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ABSTRACT

Ninety-six male and female college students participated in an experiment designed to examine the feasibility of isolating the critical attributes in a given instructional example as an error correction mechanism for the purpose of improving instructional effectiveness and efficiency. Results indicated that although students with the critical attribute isolation correction method failed to show higher learning in a posttest than students with a conventional error correction method, the former students took less time on the posttest. Results also support research which suggests that error correction is an effective and efficient instructional strategy for computer-based instruction. (CHV)

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Error Correction as an Adaptive Instructional Strategy for Computer-Based Instruction

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Tennyson and Rothen (1977) designed a computer-based adaptive instructional system which used a Bayesian statistical procedure to prescribe instruction to students according to individual student needs both prior to and during learning. This adaptive system provided a dynamic environment which updated each student's on-task learning progress toward mastery and modified the instructional sequence accordingly. However, in terms of adaptive instructional system, Landa (1976) contended that it should not only monitor the student's performance but also diagnose the student's errors and correct them.

The question of how to diagnose error and correct them during instruction has not been seriously considered and researched. Although no single instructional design strategy is available, there is evidence to show that error correction can make a difference in terms of student performance (Landa, 1976; R. Tennyson, Woolley, & Merrill, 1972; R. Tennyson, Steve, & Boutwell, 1975).

Is error in learning harmful to learning process? Whether error response interferes with learning has been debated in the literature on programmed instruction (Klaus, 1965). Some instructional designers are likely to emphasize that errors should be minimal(Holland, 1960). Having a learner repeat a wrong response is undesirable, and possibly aversive. Other instructional designers tend to believe that error rate cannot be optimally zero when considered in terms of instructional efficiency or the individual differences among learners. The difference in viewpoints

is particularly pronounced with respect to the consequence of an error; whether it can be ignored, must be overcome, or actually contributes to learning.

However, there is no strong evidence or universal agreement that errors are harmful. Instructional designers who emphasize on design of stimulus suggest that errors may be integral or at least benefical to the learning process (e.g., Pressey, 1963). They regard occassional errors as facilitating, either as an aid to the development of concepts or as a means of maintaining the attention of the learner.

If errors do not impair learning, then how do errors contribute to learning? In order to achieve learning from errors, the psychological mechanism of learning has to be known first (Landa, 1976). What do we know about the learning process when it is considered in terms of error responses? A majority of the past research studies have dealt with the role of learning errors in an indirect and descriptive way, such as hypotheses testing and errors (Restle, 1962), confidence and errors (Coltheart, 1973), latency and errors (Falmagne, 1970), anxiety and errors (Tennyson and Woolley, 1971). Why they have mentioned error reponses data in their research report is merely because error responses happens to be there and seems to have a correlation with the research results (e.g., Falmagne, 1972; Halff,1975).

Definition of Error. Bruner, Goodnow, and Austin (1956) state that the term "error" should be used for two specific forms of behavior. First, an error represents the failure of an overall

strategy to meet the requirements imposed by a task. To the degree that the strategy is maladaptive, it is an "error". In other words, error may be spoken of in this sense as a strategy that proves to be malfunctional in a given problem situation. Second, error must be defined not with reference to the abstract success or failure of a given response, but by reference to the fittingness of a particular act in a sequence of acts.

An error in learning concepts is either a student's failure to isolate all of the critical attributes of a concept (Landa, 1976) or not knowing the algorithm (rule) to identify a given concept (Landa, 1974). Concept instruction will be more effective if the critical attributes of a concept and the algorithm for identifying a given concept are adequately considered in the design of concept lessons. The importance of error in learning has been investigated by Anderson (1970) and Kulhavy, Yekovich, and Dyer (1976). However, how the student learns from his or her error has not been addressed. Previous studies have indicated that a student will be more likely to spend a substantial amount of time in trying to locate the source of his or her errors (Dyer, Yekovich, & Kulhavy, 1978; Levine, 1969). If concept instruction provides an opportunity for the student to take a closer look at his or her error and isolate the critical attributes in a given example, then it may facilitate learning (cf. Anderson, 1970).

The objective of the present study was to examine the feasibility of isolating the critical attributes in a given example as an error correction mechanism for the purpose of improving

instructional effectiveness and efficiency. More specifically, the study was designed to answer the following two questions:

1. Is the critical attributes isolation procedure useful in correcting students learning errors in terms of post-test performance?
2. How efficient is the critical attributes isolation procedure in terms of the post-test time?

(Note: Since the feedback variable has been widely recognized as a vital component in an adaptive instructional system, therefore the author will not mention it in detail. However, error correction has not been researched and integrated into an adaptive instructional system, therefore a detailed description and report are provided.)

Method

Participants. Participants in this study was paid, volunteer undergraduate male and female students at the University of Minnesota. Subjects was randomly assigned to treatments. The number of subjects was 96.

Design and Data Analysis. The design was a 2 x 3 with independent variables: Error correction (critical attribute error correction procedure and conventional method of instance error correction), and Feedback (knowledge of results, analytical explanation, and process feedback). Dependent variables in this study was posttest scores, number of examples required on-task, and time on learning task, posttest time and posttest confidence.

The data analysis consisted of a multivariate analysis of covariance and univariate analysis. The covariates were the pretest scores, syllogism scores, pretest time, and pretest confidence.

Learning Task. R. Tennyson and Rothen's (1977) four psychological concepts (positive and negative reinforcement, and positive and negative punishment) was used as the learning task. The validation of this learning task was assessed in a previous study (C. Tennyson, R. Tennyson & Rothen, in press).

Results. The multivariate analysis of covariance test on the main effect of error correction method was significant ($P < .001$). The test on the second main effect, feedback types, was likewise significant ($P < .05$). The interaction test between the two indenpendent variables was non-significant. The analysis of variance on the posttest correct scores showed no significant difference on the error correction method. For the main effect of feedback types on posttest score, there was a significant difference, $F(2, 86) = 13.13$, $P < .05$. A contrast test between the three groups on the main effect feedback types, process feedback versus analytical explanation feedback, resulted in a significant difference, $F(1, 86) = 5.79$, $P < .05$. The contrast between the analytical explanation feedback group and knowledge of results feedback group was nonsignificant. Process feedback groups have the pretest to postest gain score 74.3%, while the analytical explanation feedback groups and knowledge of results feedback groups have 59%, and 60% respectively. Analysis of variance test on the subscores of each concept of the posttest showed no

significantly differences both on the error correction methods and feedback types. The error correction effect on posttest time was significant ($P < .05$). Analysis of variance test on the efficiency ratio (posttest score/posttest time) showed an error correction effect, $P < .05$. Analysis of variance on the posttest confidence showed an interaction effect, $P < .05$. The analysis of variance test on the number of instances presented on-task, and on-task time showed no significant differences both on the error correction methods and feedback types.

Conclusions

The two error correction methods investigated used previously defined methods for correction of error response within a given concept class. The examples within each concept also had divergent variable used to isolate the error responses to the level of critical attributes identification. However, the results of this study did not provide evidence that critical attributes error reponse correction procedure has better results in learning than a conventional method of error response correction. It is because in both conditions students stayed on task until mastery was reached, thus differences, if any, would be small. Landa (1974) maintained that once a student learns the course of action to use in performing a task, the time he or she takes to solve subsequent and similar tasks will be shortened. This study showed that critical attribute isolation error correction procedure groups took less time to finish

the posttest than the conventional method of instance error response correction groups. It can be infered that the reason students finfshed the posttest in a more efficient manner was possibly due to they identified the process involved in going about knowing the given concepts.

Disscusions

The implications of this study, when combined with the previously reviewed error reponse and learning research, are that critical attribute isolation error correction procedure can help the students not only to master learning but also finish the posttest in a more efficient manner. Although the results showed that in terms of posttest score, there was no significant difference between the two methods, there was a difference between the time they spent on the posttest. Critical attribute isolation error correction procedure isolated student error to the level of critical attribute identification. It can be infered that the groups receiving this strategy have possibly recognized the identification process of a given concept. Therefore, they needed less time to finish the posttest. In the effectiveness and efficiency point of view, critical attributes isolation error correction procedure would help the student to reach the proficiency level. L. Anderson and Block (1977) contend that there are differences between the concepts: Mastery, competency, and proficiency. Mastery implies the designation of both the desired learning outcome and the level of performance which will be accepted

as an indication of the acquisition of the learning outcome. Competency is a two-dimensional construct. The first dimension is mastery. In other words, mastery can be thought of as the intellectual component of competent learner has acquired a varity of learning products, and also consists of the attainment of self-confidence or the sense of being able to cope. L. Anderson and Block point out proficiency is the efficiency with which the individual make use of the acquired learning products. While mastery refers to the effectiveness of the learning process in producing the desired learning product, proficiency refers to the efficiency of the use of the learning product once it has been acquired. L. Anderson and Block believe that proficiency follows mastery. This study found that L. Anderson and Block's postulation is reasonable. The students in the critical attribute isolation error correction procedure groups reached the mastery level and performed efficiently in posttest. Certainly this adaptive instructional system would bring the student from the mastery stage to proficiency stage. Further test on this strategy is necessary.

Future Direction for Research

Error diagnosis and correction is the essential component of a truly adaptive instructional system. This study has showed that the students have possibly identified the individual critical attribute of a given concept when they have made errors. However, the relationships between (or among) the critical attributes have not been demonstrated in the correction procedure. The future direction in this area can be not only isolate the critical attributes of a given concept but also display the relationships between and among the critical attributes.

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